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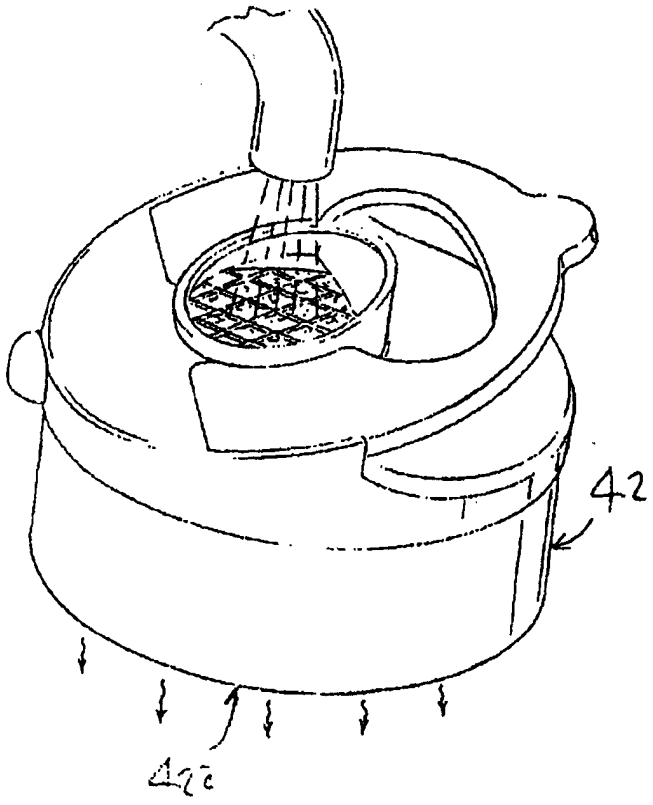
(54) Title: AIR CLEANER WITH WASHABLE FILTER



(57) Abstract: A vacuum cleaner (20) includes a cyclone separator (38) and an electrostatic precipitator (40) downstream of the cyclone separator (38) in the air flow path through the vacuum cleaner (20). The electrostatic precipitator (40) includes a washable filter element (40) enclosed in a housing (42) that is removable from the vacuum cleaner (20) as a unit. The housing (42) protects a user from contact with the dirty filter element (40) and has water inlet (62, 74) and outlet openings (42A, 74) through which water can be directed to flush dirt from the filter element (40).

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Title: AIR CLEANER WITH WASHABLE FILTER

FIELD OF THE INVENTION

This invention relates generally to air cleaners, for example, vacuum cleaners.

BACKGROUND OF THE INVENTION

The invention has been devised primarily, though not exclusively, in the context of vacuum cleaners that include at least one cyclone separator for cleaning air that flows through the vacuum cleaner, and a secondary filter downstream from the cyclone separator, for removing small particulate matter.

Cyclone separators, which are sometimes referred to merely as cyclones, are devices that use centrifugal force and low pressure caused by spinning motion, to separate materials of differing density, size and shape. Cyclone separators are disclosed, for example, in United States Patents Nos. 3,425,192 and 4,593,429.

PCT Publication No. WO 00/40135 published July 13, 2000 discloses a vacuum cleaner that includes a cyclone separator in combination with a downstream electrostatic precipitator for removing fine particulate matter from the air that passes through the cyclone separator. As disclosed in this publication, the cyclone separator is removable from the vacuum cleaner as a unit and the unit includes a bin for collecting dirt that has been removed by the cyclone. The bin can be separated from the remainder of the cyclone and emptied.

Cleaning of the electrostatic precipitator is a separate challenge. In general, users of vacuum cleaners find it distasteful if they are required to come into contact with the dirt that has been removed from the air flowing through the vacuum cleaner. Similar issues arise with other forms of secondary filter.

SUMMARY OF THE INVENTION

Broadly speaking, the present invention provides an air cleaner in which air is caused to flow along an air flow path from a dirty air inlet to a

clean air outlet, wherein the air cleaner includes a washable air filter disposed in the air flow path. The filter is enclosed in a housing that is removable from the air cleaner as a unit and the housing encloses the filter so as to protect a user from contact with the filter itself. The housing has water inlet and outlet openings arranged to allow wash water to be directed through the filter to flush dirt from the filter without the user contacting the filter.

Preferably, the air cleaner includes a cyclone separator in combination with the washable air filter and the washable air filter is disposed downstream of the cyclone separator. More preferably, the filter is an electrostatic filter of the type in which the filter is electrostatically charged by the air that flows through the vacuum cleaner. PCT Publication No. WO 00/40135 mentioned previously discloses an electrostatic filter of this type.

In a preferred embodiment as applied to vacuum cleaners, both the cyclone separator and the electrostatic air filter are incorporated in a filter assembly that is removable as a unit from the vacuum cleaner. The assembly may include a generally cylindrical dirt collection bin, and the housing of the electrostatic filter may be incorporated as part of a closure at the top of the bin. Air leaving the cyclone when the vacuum cleaner is in use flows upwardly through the electrostatic filter and out through an opening in the top of the filter housing. When the closure is removed from the cyclone bin, the outlet opening can then act as either the water inlet or outlet for flushing the electrostatic precipitator.

BRIEF DESCRIPTION OF DRAWINGS

In order that the invention may be more clearly understood, reference will now be made to the accompanying drawings which illustrate a number of preferred embodiments of the invention by way of example, and in which:

Fig. 1 is a perspective view of an upright vacuum cleaner in accordance with the present invention;

Fig. 2 is a perspective view of the filter assembly of the vacuum

cleaner;

Fig. 3 is a vertical sectional view through the filter housing of the filter assembly shown in Fig. 2, after removal of the cyclone bin, and showing flushing water flowing through the housing;

Fig. 4 is an exploded perspective view corresponding to Fig. 3 showing the electrostatic filter housing removed from the remainder of the cyclone structure;

Fig. 5 is a perspective view showing how the filter housing can be flushed separately from the remainder of the cyclone structure; and,

Fig. 6 is a perspective view illustrating an alternative embodiment, in which the filter housing has flush water openings in its side wall.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to the drawings, Fig. 1 shows an upright vacuum cleaner in accordance with a preferred embodiment of the present invention. The vacuum cleaner and its manner of operation are generally in accordance with the disclosure of PCT Publication No. WO 00/40135 referred to previously, to which reference may be made for specific details not found in the present disclosure.

The vacuum cleaner is generally denoted by reference numeral 20 and includes a floor cleaning head 22 that is mounted on wheels, one of which is visible at 24, for movement over a floor surface. A dirty air inlet in the underside of the head is indicated at 26 and usually will accommodate a driven rotary brush or beater bar (not shown). Extending upwardly from a rear portion of the head 22 is a support structure 28 for a filter assembly 30 that is removable as a unit from the vacuum cleaner. The filter assembly is shown separately in Fig. 2.

Above the filter assembly, the support structure 28 carries an upper body portion 32 of the vacuum cleaner that incorporates a fan and motor assembly (not shown) for drawing air through the vacuum cleaner and delivering cleaned air to a clean outlet 34 at the top of body portion 32. A handle for manoeuvring the vacuum cleaner is indicated at 36.

Referring now more particularly to Fig. 2, the filter assembly 30 includes a cyclone separator generally denoted by reference 38 and an electrostatic air filter 40 enclosed in a housing 42. A bin for collecting dirt removed by the cyclone separator is indicated at 44. Bin 44 has a cylindrical side wall 46 that is transparent. Visible through the side wall of the bin is the internal structure 48 of the cyclone separator. This includes a main inlet pipe 50 that extends upwardly centrally of bin 44 and through which dirty air enters the cyclone from the floor cleaning head 22 of the vacuum cleaner.

As best seen in Fig. 3, pipe 50 extends upwardly and then laterally to a cyclone inlet opening 52 that directs air tangentially with respect to the internal surface of the side wall 46 of bin 44. When the vacuum cleaner is in use, air entering bin 44 from inlet 52 spirals downwardly on the internal surface of bin side wall 46 until it reaches a lower baffle member or distal wall 54 (Fig. 2), which deflects the air inwardly and upwardly adjacent the outer surface of inlet pipe 50. The air then enters openings 56 in an upper housing 58 of the cyclone separator and then flows upwardly through the electrostatic filter 40 as indicated by the ghost outline arrows 60. The air then travels upwardly through filter 40 and leaves the filter assembly 30 through an opening 62 in the top of filter housing 42.

Referring back to Fig. 1, the flow path of air from the dirty air inlet 26 of head 22 to the clean air outlet 34 of the vacuum cleaner is indicated at 64. To summarize, the air travels upwardly through inlet pipe 50 of the cyclone separator to the inlet 52 of the cyclone, from where it spirals downwardly adjacent the inner surface of the side wall 46 of the cyclone bin. The air then travels back up adjacent the outer surface of inlet pipe 50 and into the openings 56 of the housing 58 of the cyclone assembly. The air then travels upwardly through filter 40, and through the upper body portion 32 of the vacuum cleaner to outlet 34.

Filter assembly 30 (Fig. 2) may be removable from the remainder of the vacuum cleaner in any manner known in the art. Preferably filter assembly 30 is removable from the remainder of the vacuum cleaner in the manner disclosed in the PCT application referred to previously, by

slightly depressing the filter assembly and then pulling it outwardly. As best seen in Fig. 3, the filter assembly housing 42 has a top surface that is angled upwardly to the right and that is shaped to provide a handle 66 that projects forwardly of the vacuum cleaner in the assembled condition, as best seen in Fig. 1. Thus, the user grasps the handle 66, depresses the filter assembly slightly and pulls it forwardly and outwardly using the handle. Fig. 2 shows the filter assembly as it would appear after removal from the remainder of the vacuum cleaner in this fashion. In an alternate embodiment, filter assembly housing 42 may be removable from the vacuum cleaner without first removing bin 44 from the vacuum cleaner.

When the vacuum cleaner is in operation, dirt that is removed from the air flowing through the vacuum cleaner by the cyclonic action of the cyclone separator accumulates in bin 44. Referring now to Fig. 3, it will be seen that the upper housing 58 of the cyclone assembly and the housing 42 of the filter 40 fit together to form a sub-assembly that also includes the inlet pipe 50 of the cyclone separator and baffle 54 (Fig. 2). The housings 42 and 58 have the same cylindrical exterior configuration and fit together so that the sub-assembly forms a cylindrical closure that is a push-fit inside the upper portion of cyclone bin 44. As seen in Fig. 3, the sub-assembly has been separated from the cyclone bin 44 by lifting the sub-assembly from the bin. Bin 44 can now be emptied of accumulated dirt. The sub-assembly shown in Fig. 3 can be conveniently manipulated by the user holding handle 66. Filter 40 can be cleaned by directing flushing water downwardly through opening 62 as indicated at 68; the water will flow down through filter 40 and out through the openings 56 in the cyclone housing part 58. Thus, the user can clean filter 40 without having to come in contact with the dirt that has accumulated on the filter and the dirt can simply be flushed away.

It should at this stage be noted that the filter 40 is shown in the drawings simply as a generally cylindrical filter structure that, in this embodiment, is an electrostatic filter of the form disclosed in the PCT application referred to previously. In principle, however, other forms of washable filter could be used, even a mechanical particle filter.

Even though the filter 40 can be cleaned successfully as part of the sub-assembly shown in Fig. 3, the filter housing 42 is preferably detachable from the cyclone housing 58 as shown in Fig. 4, and can be flushed separately as illustrated in Fig. 5. As can be seen in Fig. 4, a bayonet coupling arrangement is provided between housing 42 and cyclone housing part 58 and comprises, e.g., three equi-angularly spaced bayonet fittings 70 that are designed to allow the two housing 42 and 58 to be connected or disconnected by relative rotation with respect to one another. An actuator 72 for a detent 72a is depressed to permit such relative turning movement. When the two housings are fitted together detent 72a engages in a notch 73 in filter housing 42, preventing relative turning of the two housings. Alternate removable engagement means may be utilized such as a screw thread, a snap fit, an interference fit, screws or the like.

Housing 42 has a substantially open bottom wall 42a so that the filter can be cleaned by directing water either in through opening 62 and out through wall 42a, or in the reverse direction (after inverting housing 42). In a further embodiment, housing 42 may have first and second portions 42b and 42c which are separable so as to permit access to filter 40. For example, housing portion 42b may be removably attached to housing portion 42c by any removable engagement means known in the art such as a bayonet mount, a screw thread, a snap fit, an interference fit, screws which are received in holes 42d or the like

Finally, Fig. 6 shows an alternative embodiment of the invention. In this case, the filter housing 42 is provided with openings 74 in its side wall through which flush water can be directed and allowed to escape. As shown in Fig. 6, the openings 74 are in addition to the openings that are present in the preceding embodiment, to allow for flushing of the filter both in the direction of normal air flow through the filter (or counter to that direction) and in the radially inward direction. It is, however, to be understood that, within the broad scope of the invention, it is merely necessary that openings be provided in the housing 42 to allow flushing of the filter and that any configuration and arrangement of openings is suitable

provided normal filtering air flow can take place through the housing. Accordingly, the only openings for flushing filter 40 with water may be openings 74. In such a case, openings 74 may be the air inlet to filter housing 42 or the air outlet therefrom.

It is to be understood that the preceding description relates to particular preferred embodiments of the invention only and that various additions and modifications are possible, some of which have been indicated previously and others of which will be apparent to a person skilled in the art. In particular, it is to be noted that the invention is applicable to any type of vacuum cleaner whether upright (as illustrated), canister vacuum cleaner or central vacuum cleaner or the like. The dirty air stream which is processed may be collected, for example, by a wand or rotating brush positioned in the head of the vacuum cleaner as is known in the art. The invention may also be used with a wet/dry vacuum cleaner. The material separated by the cyclone separator of the vacuum cleaner may be removed from the vacuum cleaner by any alternate means known in the art. For example, the cyclone separator may have an opening therein to permit the separated material to be removed or the separated material may be transported to a removal station by means of a manually operate auger or the like. In the latter case, the cyclone separator need not be separable from the vacuum cleaner for routine emptying in which case an access port may be provided for removal of the housing 42.

The filter assembly may include more than one cyclone separator. The filter assembly may comprise a plurality of cyclonic separation stages that may be operated in series or parallel and, preferably, in series. In such a case, the first cyclonic separation stage may comprise a single cyclone separator and the second cyclonic separation stage may comprise a plurality of cyclone separators. Filter housing 42 could optionally be incorporated in the air flow stream between the first and second cyclonic separation stages or downstream from the second cyclonic separation stage.

The water inlets and outlets may be of any shape and size that

permit sufficient water to pass through filter 40 so that filter 40 may be rinsed. As the water passes through filter 40, it collects and removes fine particulate matter that has been collected by filter 40. The water inlets and outlets may each comprise a single opening or a plurality of openings. The openings may be of uniform size or their size may vary.

Finally, it should be noted that, while the disclosure with reference to the drawings is directed exclusively to vacuum cleaners, the invention may be applied to other forms of air cleaner, for example a room air cleaner. In this latter context, an air filter assembly, for example, of the form shown in Fig. 2 could form part of a room air cleaner in which air is caused to flow upwardly through the filter assembly and out into the room through opening 62.

I CLAIM:

1. An air cleaner in which air is caused to flow along an air flow path from a dirty air inlet to a clean air outlet, wherein the air cleaner includes a washable air filter disposed in said air flow path and enclosed in a housing that is removable from the air cleaner as a unit, the housing enclosing the filter so as to protect a user from contact with the filter and including at least one wash water inlet and at least one wash water outlet arranged to allow wash water to be directed through the housing to flush dirt from the filter.

2. An air cleaner as claimed in claim 1, wherein the washable air filter is an electrostatic air filter.

3. An air cleaner as claimed in claim 1, wherein the washable air filter is an electrostatic air filter of the type that is electrically charged by air flow through the filter in use.

4. An air cleaner as claimed in claim 1, wherein the air filter forms part of a filter assembly that is removable from the air cleaner as a unit, and wherein the filter assembly includes a cyclone separator upstream of said air filter in said air flow path, the cyclone separator having a cyclone bin and a cyclone structure poitioned within the bin and removable from the bin.

5. An air cleaner as claimed in claim 4, wherein the cyclone structure is coupled to the air filter housing to form a sub-assembly that comprises a removable closure for the cyclone bin, the filter assembly having a filtered air outlet which comprises said wash water inlet of the air filter and including openings communicating with said wash water outlet of the air filter for permitting flushing of the air filter after the removal of the cyclone bin from the filter assembly.

6. An air cleaner as claimed in claim 5, wherein the air filter housing is detachably coupled to the cyclone structure so that the air filter can be separated from the said sub-assembly for cleaning.

7. An air cleaner as claimed in claim 1, wherein said air filter housing has a generally cylindrical side wall, a top wall having a filtered air outlet opening, and a bottom wall which is substantially open, said substantially open bottom wall and air outlet opening comprising said water inlet and outlet of the air filter housing.

8. An air cleaner as claimed in claim 1, wherein said wash water inlet and outlet comprise openings in a side wall of the filter housing.

9. A vacuum cleaner having a dirty air inlet, a clean air outlet spaced from the dirty air inlet, and an air flow path extending from the dirty air inlet to the clean air outlet, wherein a filter assembly is positioned in said air flow path and comprises at least one cyclone separator in communication with the dirty air inlet and at least one electrostatic precipitator positioned in the air flow path downstream from said cyclone separator, wherein the electrostatic precipitator includes a washable air filter enclosed in a housing that is removable from the vacuum cleaner as a unit, the housing enclosing the filter so as to protect a user from contact with the filter, and including at least one wash water inlet and at least one wash water outlet arranged to allow wash water to be directed through the housing to flush dirt from the filter.

10. A filter assembly for an air cleaner, comprising:

a washable air filter disposed in an air flow path through the filter assembly, wherein the filter is enclosed in a housing which protects a user from contact with the filter and which includes at least one wash water inlet and at least one wash water outlet arranged to allow wash water to be directed through the housing to flush dirt from the filter;

a cyclone separator upstream of said air filter in said air flow path, the cyclone separator having a removable cyclone bin and including a cyclone structure within the bin, wherein the cyclone structure is coupled to the air filter housing to form a sub-assembly that acts as a removable closure for the cyclone bin, the filter assembly having a filtered air outlet which comprises said wash water inlet of the air filter and including openings communicating with said wash water outlet of the air filter for permitting flushing of the air filter after removal of the cyclone bin from the filter assembly.

11. A filter assembly as claimed in claim 10, wherein the air filter housing is detachably coupled to the cyclone structure so that the air filter can be separated from the said sub-assembly for cleaning.

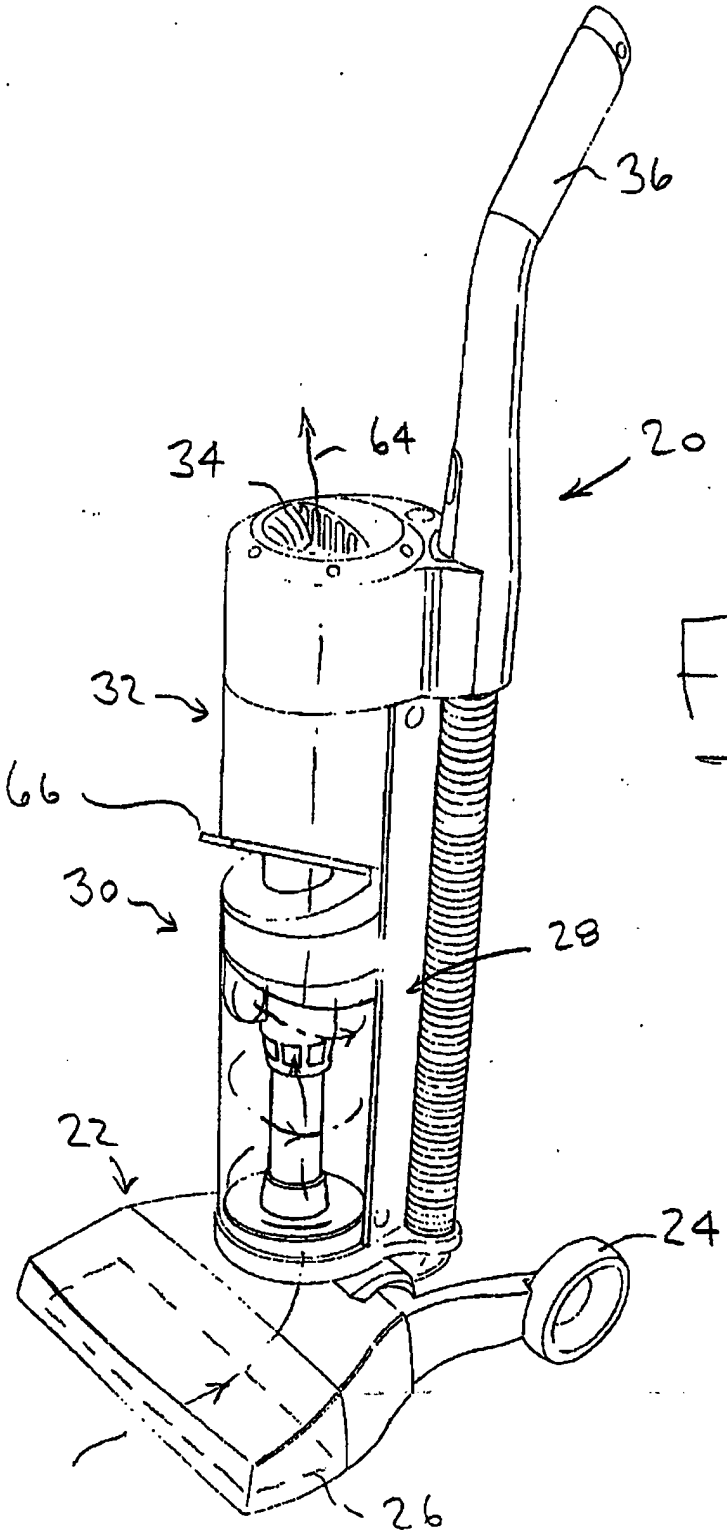

Fig. 1

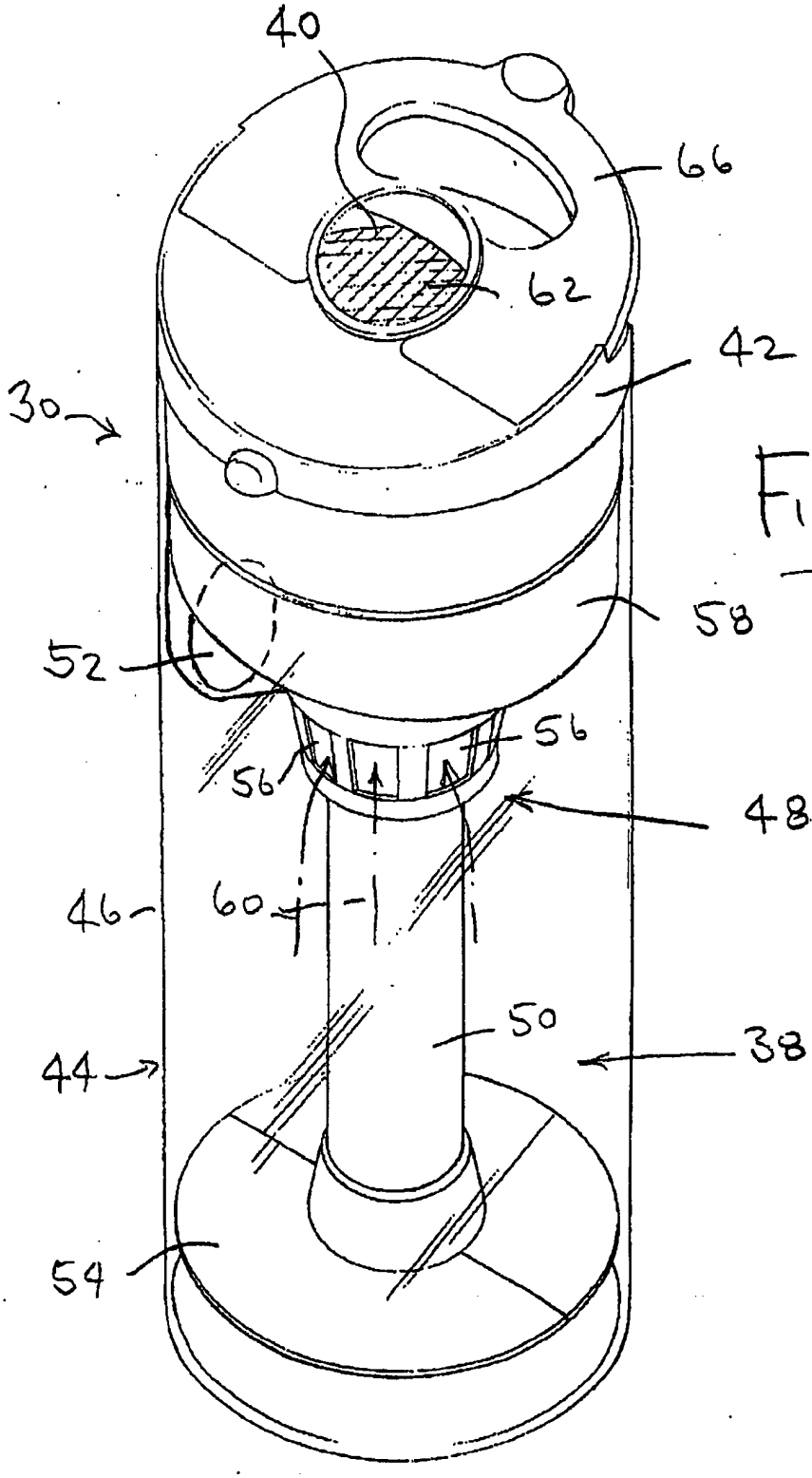

Fig. 2

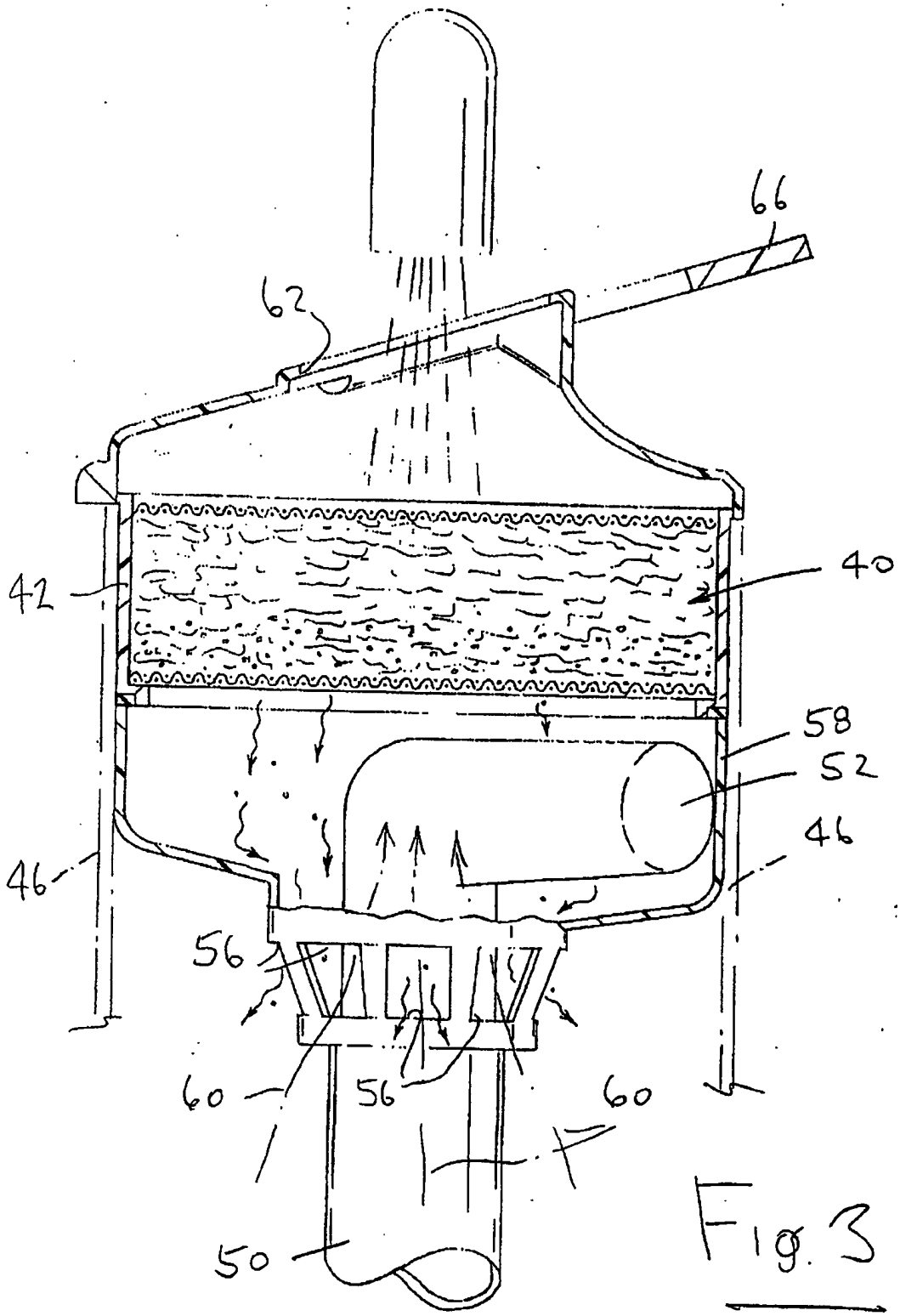

Fig. 3

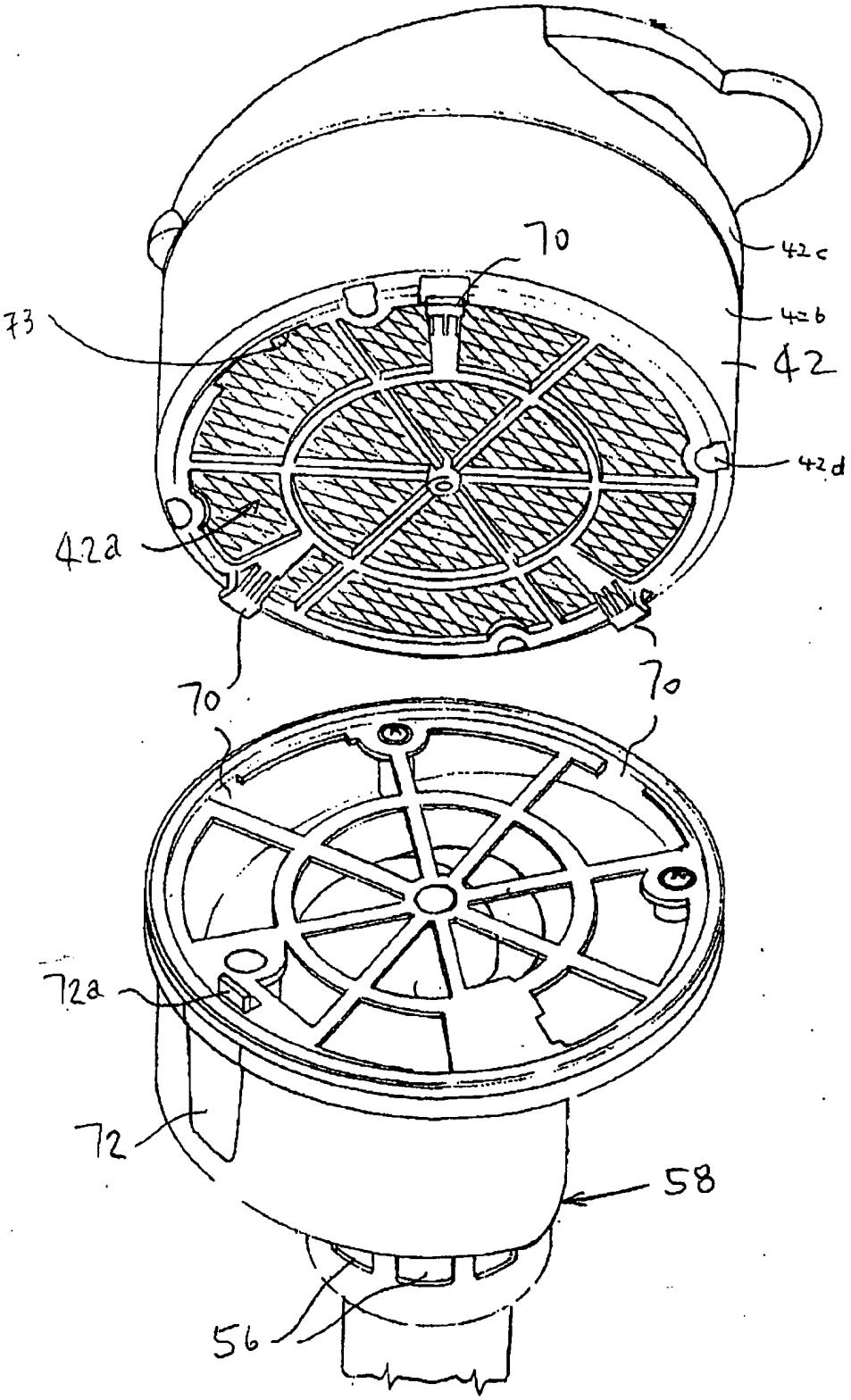

Fig. 4

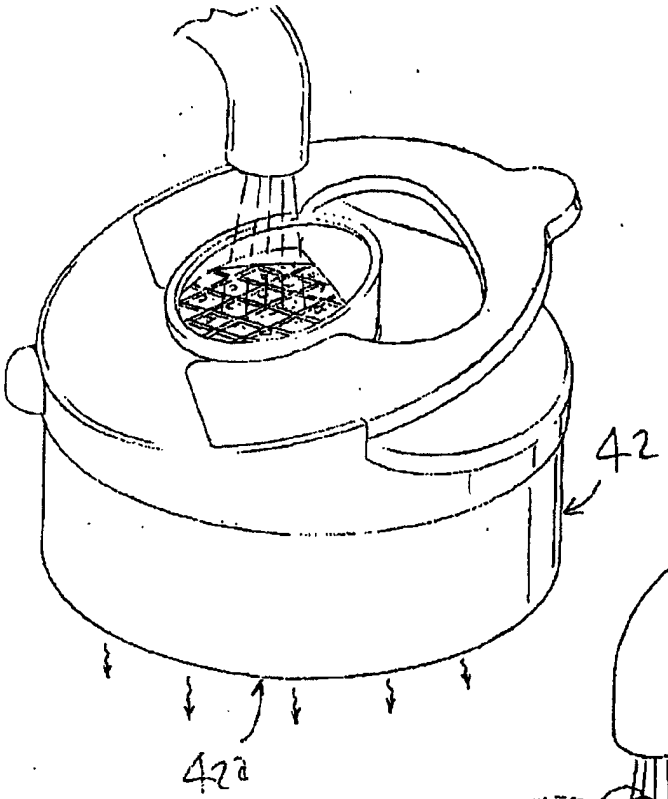

Fig. 5

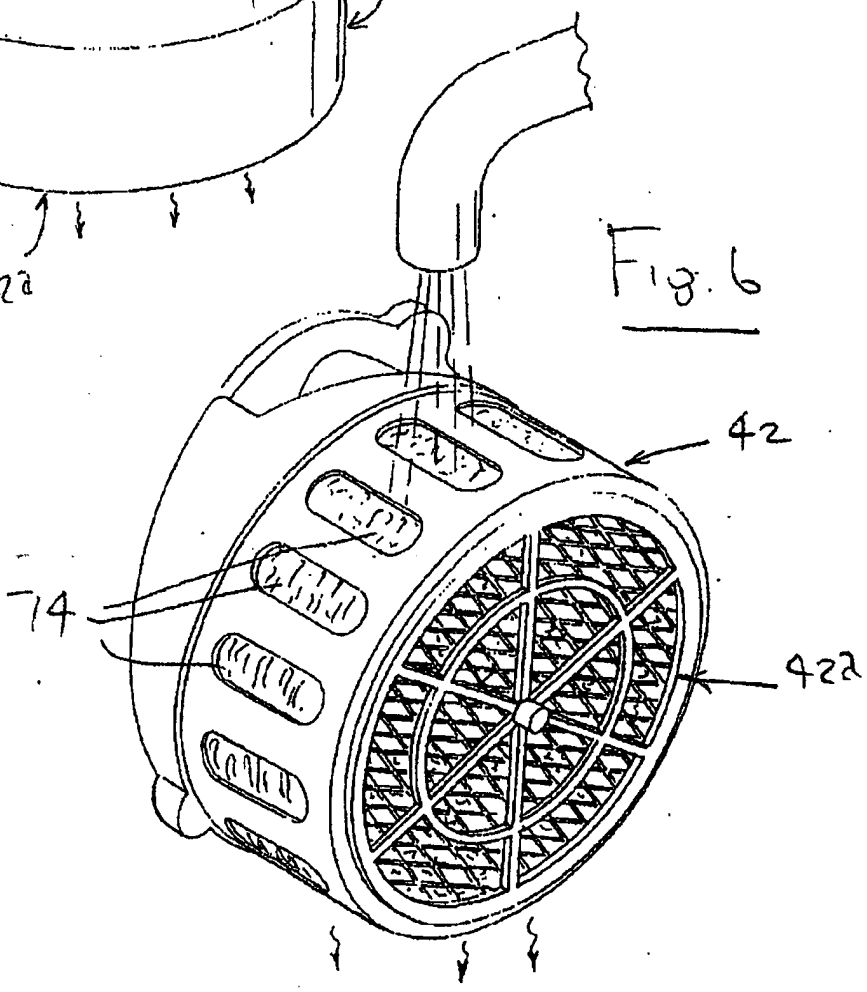

Fig. 6

INTERNATIONAL SEARCH REPORT

International Application No
PCT/CA 02/00422

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A47L9/20 B01D46/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A47L B01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

'A' document defining the general state of the art which is not considered to be of particular relevance

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Date of the actual completion of the international search	Date of mailing of the international search report
13 August 2002	21/08/2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Cabral Matos, A

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INTERNATIONAL SEARCH REPORT

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PCT/CA 02/00422

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
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